7N #64232

NSTS 08398

STS-34 NATIONAL SPACE TRANSPORTATION SYSTEM MISSION REPORT

NOVEMBER 1989

NASA
National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

(NASA-TM-105488) STS-34 NATIONAL SPACE TRANSPORTATION MISSION REPORT (NASA) 26 p

N92-70409

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NSTS-08938

STS-34

NATIONAL SPACE TRANSPORTATION SYSTEM

MISSION REPORT

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December 1989

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INTRODUCTION

The STS-34 National Space Transportation System (NSTS) Program Mission Report contains a summary of the vehicle subsystems' activities on this thirty-first flight of the Space Shuttle and this fifth flight of the OV-104 Orbiter vehicle (Atlantis).

The primary objective of the STS-34 mission was to successfully deploy the Galileo/Inertial Upper Stage (IUS) spacecraft. There were no secondary objectives assigned to this mission, although 12 development test objectives (DTO's), 9 detailed supplementary objectives (DSO's), 7 experiments, and 1 student experiment were assigned. A discussion of the accomplishments concerning these DTO's and DSO's is contained in the latter portion of this report.

The crew for this mission was Donald E. Williams, Capt., U. S. Navy, Commander; Michael J. McCulley, Cmdr., U. S. Navy, Pilot; Shannon W. Lucid, Ph.D., Mission Specialist 1; Franklin R. Chang-Diaz, Ph.D., Mission Specialist 2; and Ellen S. Baker, M.D., Mission Specialist 3.

The sequence of events for this mission is shown in Table I. This report also summarizes the significant problems that occurred during the mission. The problem tracking list is presented in Table II to provide the reader with a complete list of all Orbiter problems. The anomalies that occurred on the Solid Rocket Booster (SRB), External Tank (ET), and Space Shuttle main engines (SSME's) are also discussed with a reference given to the MSFC In-flight Anomaly List, which may be obtained from Flight Evaluation personnel at MSFC. Each of the Orbiter, SRB, ET, and SSME anomalies is discussed within the body of the report and a reference number is provided.

MISSION SUMMARY

The STS-34 mission was scheduled to be launched from launch pad 39B on October 17, 1989, at 12:57 p.m.e.d.t.; however, unsatisfactory weather at the return-to-launch-site (RTLS) runway caused the launch to be scrubbed. The launch was rescheduled for 12:50 p.m.e.d.t. on October 18, 1989.

The launch countdown proceeded nominally for the launch on October 18, 1989. The countdown was resumed after the final planned hold at T-9 minutes, but was held for 3 minutes and 40 seconds at T-5 minutes to update the onboard computer and the switch configuration to reflect the change in the primary transatlantic (TAL) abort site from Ben Guerir to Zaragosa. The weather at the primary TAL abort site was unacceptable because of a rain shower near the runway. The exhaust gas temperature (EGT) sensor on auxiliary power unit 3 failed about 4 minutes prior to launch, but the failure had no impact on the countdown or mission.

The STS-34 mission was launched satisfactorily at 291:16:53:40.020 G.m.t. (11:53:40.020 p.m.c.d.t.) on an inclination of 34.30 degrees, and the Orbiter was placed in the planned orbit. Launch phase performance of the SRB's, ET, SSME's, and main propulsion subsystem (MPS) was satisfactory in all respects. First-stage ascent performance was nominal with SRB separation, entry, deceleration, and water impact occurring as anticipated. Main engine cutoff (MECO) occurred approximately 512 seconds after lift-off. The SRB's were recovered satisfactorily and the ET impacted in the targeted footprint.

Auxiliary power unit (APU) 1 experienced an uncommanded shift to high-speed operation during ascent; however, the APU continued to operate satisfactorily in high-speed.

An input/output error occurred in the flight critical multiplexer/demultiplexer (MDM) flight aft (FA) 1 prior to the orbital maneuvering subsystem (OMS) 2 maneuver. Operation of this MDM was recovered through port moding during OPS 2 operation.

Following main engine cutoff (MECO), the high-load inboard duct heater temperature in the flash evaporator (FES) started dropping, indicating water carry-over into the duct. The FES shut down and the secondary FES controller operated satisfactorily. The FES duct heaters were activated in an attempt to thaw any ice that may have been present in the FES core or ducts. A test of the FES was conducted of the topping evaporator with the primary B controller, and the FES operated properly. The FES was operated satisfactorily for the remainder of the mission.

No orbital maneuvering subsytem (OMS) -1 was required. The OMS-2 maneuver was performed at 291:17:33:35.7 G.m.t., with a firing duration of 140.8 seconds and a differential velocity of 220 ft/sec. All subsystems operated satisfactorily during the maneuver; however, because of the MDM FA1 problem, the left OMS engine was operating on the secondary gimbals.

The Galileo spacecraft was deployed on time and performance was nominal. A 16.8-second OMS separation maneuver was performed as planned at 291:23:30:02.2 G.m.t., with a differential velocity of 31 ft/sec.

During the mission, the APU 3 drain line pressure slowly increased to 26 psi while the pump inlet pressure slowly decreased to 139 psi. These values indicated a small leak through the fuel pump seal. This small leak did not impact mission operations.

At 291:22:00 G.m.t., the APU 1, 2, and 3 gas-generator fuel-pump (GG/FP) system A heaters were turned on. APU 1 and 3 responded normally, but the APU 2 heaters apparently did not operate. This same failure occurred on STS-27 and STS-30. The APU 2 system B heaters were selected and operated properly.

During day 2 activities while operating on the B heaters, the right OMS engine cover heater failed to operate. Control was switched to the A-heater system and satisfactory temperatures were maintained.

The crew reported two jams of the 70-mm Hasselblad 100-mm lens assembly. The crew used an unjamming procedure to regain normal operation of the lens after the first jam. However, after the lens jammed again later in the flight and could not be unjammed, the camera and lens were stowed for postflight evaluation. Another 70-mm camera was available for use during the rest of the mission; however, the loss of this camera for the rest of the mission reduced the operational flexibility for crew photographic operations.

The cryogenic oxygen manifold valve 2 failed to close when commanded by the crew as they were preparing for sleep on day 2. The hydrogen manifold valve 2 was cycled and operated properly, indicating the control bus was satisfactory. After the crew was awakened on day 3, the switch controlling the cryogenic oxygen manifold valve 2 was actuated and the valve closed when commanded by the crew. The valve remained closed for the rest of the mission.

A problem was noted with the text and graphics system (TAGS) in that the paper was curling/folding in the paper tray after exiting the development processor. This condition limited the number of pages to 30 that could be transmitted at one time, but this limitation did not impact the mission.

Early in day 4, (296:06:00 G.m.t.), the APU 2 fuel-pump bypass-line temperature sensor (V46T0228A) exceeded the fault detection annunciator (FDA) limit of 180 °F while operating on B heaters. The crew was awakened and the heater control switch was placed in the A-heater position to maintain temperature telemetry. In addition, the crew maneuvered the vehicle to a biased top-solar-inertial attitude, which maintained the APU components at acceptable temperatures. When day 5 crew activities began, the crew switched back to the B heater and the heaters operated erratically, but temperatures were maintained within established limits.

On day 4, because of expected unsatisfactory weather conditions at the primary landing site (Edwards AFB), the planned landing was moved up one revolution with a morning landing planned for Monday, October 23, 1989. In addition, consumable-conservation activities were instituted, should a mission extension of up to 3 days be required because of unsatisfactory weather conditions at the landing sites. On day 5, the planned landing time at Edwards AFB was moved up an additional revolution, with the landing planned for 11:32 a.m.c.d.t. on October 23.

Late in the flight, the waste-water tank-quantity transducer displayed erratic readings at the 57.2-percent quantity, but the readings stabilized above 57.2 percent. This anomaly has been observed on previous flights and had no effect on the mission.

In light of the APU 1 uncommanded shift to high speed during ascent, APU usage was modified for the remainder of the mission. APU 3 was used for the flight control system (FCS) checkout instead of APU 1. APU 2 was the first APU started for entry (5 minutes prior to deorbit maneuver ignition). APU 3 was started 13 minutes prior to entry interface, and APU 1 was started at approximately Mach 10 (11.5 minutes before landing) and was shut down shortly after wheels stop.

The FCS checkout was conducted at 295:12:11:03.58 G.m.t., and all systems performed satisfactorily. APU 3 ran for 5 minutes 39.57 seconds and 19 lb of fuel was used during the checkout. EGT 2 sensor on APU 3 failed during the FCS checkout, but this failure did not affect APU operation during the checkout nor did it affect operation during entry.

The hot-fire test of the primary reaction control subsystem (RCS) thrusters was also performed satisfactorily during the FCS checkout. The Pilot's horizontal situation indicator (HSI) primary hundreds-of-miles digit reading was erroneous during the OPS 8 dedicated display checkout portion of the FCS checkout.

During S-band antenna switching operations, a malfunction of the upper-right was noted when operating on switch-beam control electronics 2. Additionally, the upper left antenna had an intermittent beam switch failure while operating on switch beam control electronics 1. These malfunctions did not impact mission operations.

While configuring for entry, the water spray boiler 2 vent temperature did not respond when operating on controller A. Control was switched to controller B and normal temperatures were observed. After completion of all final entry preparations and stowage, the OMS deorbit maneuver was performed as planned at 296:15:31:45.0 G.m.t., with a firing duration of 166.4 seconds and a differential velocity of approximately 321 ft/sec. At 296:15:41 G.m.t., APU 2 exhaust gas temperature 1 failed. This failure did not affect APU operation during entry.

Entry interface occurred at 296:16:02:15 G.m.t., and all subsystem performance and entry operations were nominal. The normal entry blackout period did not occur as communications were maintained using the TDRS satellite network. Main landing gear touchdown occurred at 296:16:33:00 G.m.t. (11:33:00 a.m. c.d.t.) on lakebed runway 23 at Edwards AFB. Nose landing gear touchdown followed 11 seconds later with wheels-stop at 296:16:34:01 G.m.t. The rollout was normal in all respects, and the crew performed the high-speed nose wheel steering DTO during the rollout. The total time of the flight was 119 hours 39 minutes 20 seconds. All postflight subsystem reconfigurations were completed as planned with one APU (1) shut down 1 minute 25.08 seconds after wheels stop and the remaining 2 APU's shut down by 16 minutes 41.19 seconds after landing. The mission was successfully concluded when the crew egressed the Orbiter at 296:17:14:35 G.m.t.

The STS-34 mission was very successful in the area of experiments, and almost all experiment objectives were met during the mission.

Nine of the 13 DTO's assigned to STS-34 were accomplished. All nine DSO's were accomplished with crew reports on several of them in-flight.

SOLID ROCKET BOOSTERS

All SRB systems performed as expected. The SRB prelaunch countdown was normal. Power-up of the solid rocket motor (SRM) joint-protection heaters was accomplished routinely, and all joint and case temperatures were maintained within acceptable limits throughout the countdown. Ground purges maintained the nozzle flex bearing and igniter temperatures within expected ranges. The SRM propulsion performance was well within the required specification limits, and propellant burn rates for both SRM's were near normal. SRM thrust differentials during the buildup, steady-state, and tailoff phases were well within specifications. All SRB thrust vector control (TVC) prelaunch conditions and flight performance requirements were met with ample margins. All electrical functions were performed properly. No SRB or SRM Launch Commit Criteria (LCC) or Operations and Maintenance Requirements and Specification Document (OMRSD) violations occurred.

The SRB flight structural temperature response was as expected. Postflight inspection of the recovered hardware indicated that the SRB thermal protection subsystem (TPS) performed properly during ascent with very little TPS acreage ablation.

Separation subsystem performance was entirely normal with all booster separation motors (BSM') expended and all separation bolts severed. Nose cap jettison, frustum separation and nozzle jettison occurred normally on each SRB. The entry and deceleration sequence was properly performed on both SRB's. SRM nozzle jettison occurred after frustum separation, and subsequent parachute deployments were successfully performed. The drogue and main parachutes as well as the SRB's were successfully recovered.

Nine in-flight anomalies (IFA's) were identified as a result of the observed damage to the SRB's and SRM's. These were:

1. The hold-down stud at hold-down post (HDP) 2 hung up during lift-off, resulting in broaching of the right SRB aft skirt HDP 2 (MSFC STS-34-B-1). The shoe also lifted from the main launch platform (MLP) post during this same time period.

2. A 6-inch wide by 24-inch long piece of MSA-1 (insulation) was missing from the forward section of a system tunnel cover on the right SRB forward skirt (MSFC STS-34-B-2). A clean substrate was found, indicating no evidence of heating effects.

3. One of the two redundant 12-second reefing line cutters (located at gore 60) on the left SRB drogue parachute failed to actuate (MSFC STS-34-B-3).

4. The left SRM 45-degree rock actuator bracket was damaged at the aft exit cone (MSFC STS-34-M-1).

5. Unbondings of the forward edge were found on the left SRM forward segment dome-to-cylinder factory joint weatherseal and the forward center segment factory joint weatherseal (MSFC STS-34-M-2). The dome-to-cylinder factory-joint unbond was located from 225° to 248° and had a maximum axial depth of 2.05 inches. The second area of unbonding was located on the forward center segment factory joint weatherseal at 0°, with a circumferential length of 6.6 inches and a depth of 1.75 inches.

6. Putty was found up to the aft face of the outer primary gasket and into the seal void/gland area between 234 and 5 degrees of the right SRM igniter (MSFC STS-34-M-3). Also, putty was found on the aft face of the gasket retainer (0.11-inch maximum) and under the retainer from 262 degrees to 297 degrees on the left SRM.

7. A 5-inch circumferential unbonded area on the K5NA closeout (located at the 0-degree radial position) was noted on the aft edge of the left SRM center field joint (MSFC STS-34-M-4). The unbonded area is from the JPS cork as well as the motor-case wall.

8. Blisters were found on the SRM aft dome carbon-filled EPDM of both SRM's (MSFC STS-34-M-5). The right SRM had about 15 blisters located at the 270°, 0°, 90° and near the 180° positions, with the largest of the blisters measuring 5.5 inches axially by 4.4 inches circumferentially at the 0° position. The left SRM had about 10 blisters located intermittently around the circumference, with the largest measuring 2 inches axially by 1 inch circumferentially.

9. A confined detonating fuse (CDF) in the right-hand aft booster separation motor ignition system vented through its fiberglass braid (STS-34-B-4). The CDF assembly functioned properly prior to the failure, which had no impact on mission operations.

EXTERNAL TANK

All objectives and requirements associated with ET support of the launch countdown and flight were accomplished. Propellant loading was completed as scheduled, and all prelaunch thermal requirements were met. TPS acreage performance was as expected for the existing ambient conditions, and there were no violations of the ice/frost criteria. There was no acreage ice on the ET.

ET flight performance was excellent. All electrical and instrumentation equipment on the ET performed properly throughout the countdown and flight. The ET tumble system was deactivated for this launch, and radar reports confirmed that the ET did not tumble. Entry was normal with breakup and impact within the targeted footprint. No significant ET problems were identified.

SPACE SHUTTLE MAIN ENGINE

All prelaunch purge operations were executed successfully. Launch support ground support equipment (GSE) provided adequate control capability for SSME launch preparation. All SSME parameters were normal throughout the prelaunch countdown, comparing well with values observed on previous flights. All conditions for engine start were achieved at the proper times.

Flight data indicate that SSME performance at main-engine start, thrust buildup, mainstage, shutdown, and during propellant dump operations was well within specifications. All three engines started and operated normally. The high-pressure oxidizer turbopump and high-pressure fuel turbopump temperatures were normal throughout the period of engine operation. The SSME controllers provided proper control of the engines throughout powered flight. Engine dynamic data generally compared well with previous flight and test data. All on-orbit activities associated with the SSME's were accomplished successfully. No significant SSME problems have been identified. The SSME liquid oxygen prevalve closed indication (V41X1135E) signal was lost at MECO + 13.25 seconds. The valve performed nominally during entry. The loss of the indication is apparently the result of a visor opening on the valve, which is normal at the pressures observed.

SHUTTLE RANGE SAFETY SYSTEM

The Shuttle range safety system (SRSS) closed-loop testing was completed as scheduled at approximately T-45 minutes in the launch countdown. All SRSS measurements indicated that the system performed as expected throughout the flight. Prior to SRB separation, the SRB safe and arming devices were safed, and SRB system power was turned off as planned. The ET system remained active until ET separation. The system signal strength remained above the specified minimum of -97 dBm for the duration of the flight.

ORBITER PERFORMANCE

MAIN PROPULSION SUBSYSTEM

The overall performance of the main propulsion subsystem (MPS) was excellent. All pretanking purges were properly performed, and liquid oxygen and liquid hydrogen loading was completed with one liquid oxygen stop flow and revert. The liquid oxygen loading pump A126 went down during fast fill because of a electrical power interruption from Florida Power and Light. This interruption caused a drop in pump speed to a level that caused an automatic pump shutdown. The stop flow/revert resulted in about a 27 minute delay in loading the liquid oxygen tank; however, the loading was completed without any other problems. The MPS helium system performed satisfactorily. The engine interface unit (EIU) 3 bite bit 13 was set and 60-kbit engine data were lost for 5.2 seconds during prelaunch operations (STS-34-02). The data stream returned, and there was no impact.

The calculated liquid hydrogen load at the end of the replenish cycle was about 77 lbm more than the inventory load. The calculated liquid oxygen load at the end of the replenish cycle was about 212 lbm less than the inventory load. This represents an estimated loading accuracy of +0.03 percent for the liquid hydrogen and -0.015 percent for the liquid oxygen.

During preflight operations, no hazardous gas concentrations of any significance were detected, and the maximum hydrogen level in the Orbiter aft compartment was 170 ppm on the day of the scrub, and 155 ppm on the day of launch. Both values compare well with previous data from this vehicle.

This flight marked the third time that the prepressurization of the liquid oxygen tank was intentionally reduced by 2 psi (trip level reduced from 20.5 psig to 18.5 psig) to prevent closing of the gaseous oxygen flow control valves during the engine start transient. As planned, the gaseous oxygen flow control valves remained open during the engine-start sequence and the early portion of ascent, and performed normally throughout the remainder of the flight. The minimum liquid oxygen ullage pressure experienced during the period of the ullage pressure slump was 16.2 psig.

Trajectory reconstruction indicates that the vehicle specific impulse was near the MPS assessment tag values. The average flight-derived engine specific impulse (Isp) determined for the time period between SRB separation and 3g throttling was 452.9 seconds as compared to the tag value of 453.2 seconds. Feed system performance was normal, and liquid oxygen and liquid hydrogen propellant conditions were within specified limits during all phases of operation. All net positive suction pressure (NPSP) requirements were met. Propellant dump and vacuum inerting were accomplished as planned.

Two MPS-related instrumentation failures occurred during the STS-34 mission. The facility high-point bleed temperature measurement showed a negative bias and was scaled improperly. This sensor provides the only backup data for LCC 6.2.1-09. Secondly, the main engine 1 liquid oxygen prevalve closed position indicator failed at MECO + 14 seconds. The measurement showed the prevalve was open; however, the prevalve open indicator and engine inlet pressure indicated that the prevalve was actually closed as planned. This failure did not affect the performance of the flight vehicle.

REACTION CONTROL SUBSYSTEM

The performance of the RCS was satisfactory with no anomalies occurring within the subsystem. A total of 4732.6 lb of propellant was used during the mission, including the forward RCS dump to zero percent prior to entry. During prelaunch operations, the right-pod (RP03) RCS fuel helium primary regulator leg B showed performance degradation during a regulator response test. The sluggish regulator had a transient undershoot of 15 psia and required 4 seconds to reach regulated flow pressure, which is limited to 2 seconds. A second test was performed at a higher flow rate with the same results. The regulator was waived for one flight and will be removed and replaced during the turnaround flow.

ORBITAL MANEUVERING SUBSYSTEM

The OMS performed in accordance with the specification throughout the mission. Three dual-engine firings were performed with nominal results in each case. A total of 7643 lb of oxidizer and 4687 lb of fuel was used during the three firings. One minor anomaly, failure of right-hand orbital maneuvering engine (OME) cover B-heater, occurred at 1 day 22 hours 15 minutes mission elapsed time (MET) following subsystem reconfiguration from system heater A to B (STS-34-09). This anomaly had no effect on the mission, as operation was switched back to the A heater which operated properly.

As a result of the loss of the MDM FA1, no postfiring gaseous nitrogen purge could be performed after the OMS-2 firing. This was the first occurrence during the Shuttle Program of no purge after an OMS firing. No effect was observed during the OMS-3 and deorbit maneuvers; however, the secondary gimbals were used with the left engine during the maneuvers.

POWER REACTANT STORAGE AND DISTRIBUTION

The power reactant storage and distribution (PRSD) subsystem met all mission requirements in providing 1136 lb of oxygen and 142 lb of hydrogen in support of the fuel cell operation, and 34 lb in support of cabin pressurization/breathing requirements with one minor anomaly. At 1 day 9 hours 36 minutes MET, the oxygen manifold 2 isolation valve failed to close when commanded by the crew (STS-34-12). At 1 day 19 hours 34 minutes MET following the crew sleep period, the crew again operated the control switch for this valve and the valve closed on the first attempt, and the valve was left closed for the rest of the mission. Also, the valve was opened satisfactorily during postlanding operations. Remaining reactants at landing were adequate to support a 72.8-hour extension at power levels of 13.6 kW, and 92.7 hours at a reduced power level of 12 kW.

FUEL CELL POWERPLANT SUBSYSTEM

The fuel cell powerplant subsystem performed nominally during the 180 hours of operation and fulfilled all electrical requirements for the mission. The average electrical power level was 13.6 kW and the load was 435A with the fuel cells producing 1278 lb of water during the mission. The total electrical power produced during the mission was 1626 kWh. The fuel cells were shutdown about 23 hours after landing.

The fuel cell 2 hydrogen flow meter operated erratically at 40 hours MET, and this is the same anomalous operation that was observed on the STS-30 mission (previous flight of this vehicle) as no repairs were made following STS-30.

AUXILIARY POWER UNIT SUBSYSTEM

The APU subsystem performed acceptably, and although eight anomalies were identified, none impacted the successful completion of the mission. APU 1 operated for 33 minutes 24 seconds; APU 2 operated for 1 hour 43 minutes 1 second; and APU 3 operated for 1 hour 26 minutes 11 seconds. A total of 522 lb of fuel was used during the 3 hours 42 minutes 36 seconds of operation.

APU no.	Ascent		FCS Checkout		Entry		Total	
	Run time, min	Consumption, lb	Run time, min	Consumption, lb	Run time, min	Consumption, lb	Run time, min	Consumption, lb
1	20.2	54	0.0	0.0	13.2	28	33.4	82
2	20.2	50	0.0	0.0	82.8	177	103.0	227
3	20.2	56	5.7	19.0	60.3	138	86.2	213
	60.6	160	5.7	19.0	156.3	343	222.6	522

The short operational time of APU 1 was caused by the APU uncommanded shift to high-speed operation at 291:16:56:15 G.m.t., during ascent (STS-34-04). As a result of the failure, a workaround plan was developed to use APU 3 for flight control system checkout and not start APU 1 until the vehicle had passed Mach 10 during the entry deceleration profile. In addition, APU 1 was shut down 1 minute 25.08 seconds after landing in accordance with the alternate operating plan whereas, APU's 2 and 3 were operated for about 16 minutes 35 seconds after landing.

Four anomalies were identified in the instrumentation for the APU's:

a. APU 3 injector tube temperature (V46T0374A) was biased about 50 °F low when compared with APU 2 during prelaunch and ascent operations (STS-34-03a). During entry, however, the temperature compared favorably with APU 2. This anomalous operation did not affect mission operations.

b. APU 3 EGT 1 sensor (V46T0342A) failed during prelaunch operations (STS-34-03b). This failure did not affect mission operations.

c. APU 3 EGT 2 sensor (V46T0340A) failed during ascent (STS-34-03c), and this failure did not affect the mission.

d. APU 2 EGT 1 sensor (V46T0242A) failed during entry (STS-34-03d), and the failure did not affect the mission.

About 6 hours into the mission, the APU 2 fuel-pump/gas-generator (FP/GG) heater system A did not respond when activated at 291:23:00 G.m.t. (STS-34-06). This failure occurred on this vehicle during the STS-27 and STS-30 missions. Heater system B was used for the remainder of the mission. The A heater operated satisfactorily after landing.

APU 3 fuel-pump seal-cavity drain line pressures reached 26 psi on orbit, indicating a small static fuel pump leak into the seal drain cavity (STS-34-08). The 26 psi value was 2 psi below the minimum overboard relief valve setting. The fuel pump inlet pressure also decreased during the mission from 400 psi to 139 psi. The operational limits were updated to prevent a backup flight system (BFS) systems management (SM) alert from occurring during entry. This APU exhibited a similar leak during the last flight (STS-30) with about 30 cc of hydrazine removed from the catch bottle.

About 58 hours into the mission, the APU 2 FP/GG heater system B began operating erratically (STS-34-10). Temperature measurements on the fuel system portion of the heater circuit slowly increased on a cyclic basis until the upper FDA limit of 180 °F was violated. Heater system B was turned off while the system A heater was switched on to maintain an insight into system temperatures. Additionally, the Orbiter was placed in a thermal control attitude during sleep periods to maintain proper temperature control. Heater system B was reselected whenever the crew was awake, and the system performed within limits, but erratically during these periods.

HYDRAULICS/WATER SPRAY BOILER SUBSYSTEM

The hydraulics/water spray boiler subsystem operated nominally throughout the STS-34 mission. Prelaunch, ascent, and on-orbit water spray boiler subsystem operation was satisfactory except for the failure of the water spray boiler 2 steam vent heater (STS-34-18). Control was switched to the B controller and the heater operated properly; however, one in-flight checkout item was not accomplished as a result of the switchover.

A main engine restow test was conducted after APU 2 activation for entry. The test was successful in restowing the engine, proving the procedure useful as a substitute when the TVC actuator drift positions are greater than 2 degrees.

The water spray boiler 3 regulator outlet pressure became erratic about 8 minutes after landing (STS-34-3e). The erratic operation lasted for approximately 9 minutes, after which the operation apparently returned to nominal.

ENVIRONMENTAL CONTROL AND LIFE SUPPORT SUBSYSTEM

The environmental control and life support subsystem overall performance was nominal. Following MECO, the high-load inboard duct heater temperature in the flash evaporator subsystem (FES) started dropping, indicating water carry-over into the duct (STS-34-07). The primary A controller was shut down, and the secondary flash evaporator controller operated satisfactorily. The FES duct heaters were activated in an attempt to thaw any ice that may have been present in the FES core or ducts. A test of the FES was conducted using the topping evaporator with the primary B controller, and the FES operated properly for the 1-hour test, after which the FES was operated satisfactorily on the primary A controller for about 30 minutes. The FES was then deactivated and the radiators were returned to the normal set point of 38 °F, after which the FES was again turned on with the primary A controller, and the FES operated nominally for the remainder of the mission. The radioisotope thermoelectric generator (RTG) cooling loop (cooling RTG's on Galileo) was requiring 27,000 Btu of cooling above the normal Orbiter load. Because of this configuration and the FES not operating, cabin temperatures reached 89 °F prior to deployment of the Galileo payload. Following deployment, the temperatures stabilized in the 79 to 84 °F range.

On day 2, the cabin-temperature controller was deactivated because the cabin temperature sensor was biased 5 to 8 °F high, and this resulted in the crew being cold, especially during sleep periods. A modification to correct this bias condition will be implemented on the STS-32 vehicle.

Supply water was managed through the use of the overboard dumps and the FES. Three dumps were made at an average dump rate of 1.6 percent per minute, an amount that correlates well with the previous flight.

Mission Specialist 3 reported that the iodine level in the drinking water was between 3 and 5 ppm, which is significantly lower than the levels experienced on the previous two missions. The two additional serial microbial filters alleviated the problem.

No waste water dumps were required as adequate ullage remained until the end of the mission. The waste water tank quantity transducer operated erratically at the 57.2 percent and 82.5 percent levels. This problem was known as it occurred on a previous mission of this Orbiter.

FLIGHT CREW EQUIPMENT

The flight crew equipment performed in an acceptable manner throughout the mission. The 100-mm lens assembly on the 70-mm Hasselblad camera stuck closed on two occasions (STS-34-11). The first occurrence was cleared using an in-flight maintenance (IFM) procedure; however, after the second occurrence, the camera was stowed and returned in the failed condition for postflight inspection and evaluation.

AVIONICS SUBSYSTEM

The avionics subsystems performed acceptably throughout the mission. A number of anomalies occurred, but none impacted the successful completion of the mission objectives.

Engine interface unit 3 bite bit 13 was momentarily set and 60-kbit data were lost for 5.2 seconds during the prelaunch period (STS-34-02). The condition did not recur.

Shortly after MECO, the MDM FA 1 failed, and the failure was detected by both the primary avionics software set (PASS) and the backup flight system (BFS) (STS-34-05). The MDM was recovered by port moding string 1 to secondary ports. Operation for the rest of this mission was satisfactory.

In the area of electrical power and distribution, motor 1 on right vent door 3 operated on only two of three phases when the vent doors were pre-positioned during prelaunch operations (STS-34-19). Phase B from AC bus 1 was lost when the door was opened, and phase C was lost when the door was closed. This problem was noted during the flight when the vent door was operated.

Also during the prelaunch operations, data display unit (DDU) 1 absolute memory image (AMI) was biased and tests of the DDU indicated an internal malfunction (STS-34-01). The DDU was replaced prior to flight.

The hundred's digit on the Pilot's horizontal situation indicator (HSI) primary miles display was reading incorrectly (STS-34-15). Also, the crew reported that photographs were taken of the moisture observed under the glass of the HSI during ascent.

Several false overtemperature indications from the TAGS were cleared by cycling the power to the TAGS unit (STS-34-13). Later in the mission, the overtemperature indication remained on continuously, but excellent copies were obtained from the unit.

The general purpose computer (GPC) SM issued an antenna message that was caused by the failure of the S-band control assembly to select the proper beam direction antenna (STS-34-14). In-flight troubleshooting confirmed that the control assembly failed to select the proper beam direction. About 14 hours after the first failure (during a transition from the upper left aft antenna to the upper left forward antenna), the antenna electronics assembly 1 failed to select the forward antenna (STS-34-17). Telemetry indicated that neither antenna had been selected. The problem was corrected by cycling to antenna electronics assembly 1 and then back to 2.

Television pictures from closed circuit television (CCTV) camera C had a darkened arc across the image area (STS-34-16a). The area extended through the center of the image. Also, pictures from CCTV camera B had an area of spots (STS-34-16b).

AERODYNAMICS

The aerodynamics performance in terms of vehicle response was satisfactory. The control surfaces responded as expected and the angle of attack was also as expected.

MECHANICAL SUBSYSTEMS

The mechanical subsystems which consist of the vent doors, ET doors, payload bay doors, star tracker doors, Ku-band antenna deployment mechanism, and air data probe deployment mechanisms all functioned satisfactorily, except right vent door 3. The right vent door 3 operated on only two phases during the flight each time the door was actuated (STS-34-19).

The landing/deceleration subsystem performed normally with no reported problems. Landing gear deployment time was 5.9 seconds (10 seconds maximum), and touchdown on Edwards Air Force Base lakebed runway 23 was at 204.7 knots with light winds. After nose gear touchdown at 157.9 knots, a left and right turn using nose wheel steering was executed. This maneuver moved the Orbiter 42 feet left of the centerline and then back to the centerline.

Brakes were applied at 73 knots and resulted in low brake energies. Peak deceleration was 7.5 ft/sec/sec. Total rollout distance was 9677 feet, and the duration was 57 seconds. Postlanding tire checks revealed normal tire pressures in all tires.

Postflight inspection showed that the ET/Orbiter liquid oxygen aft separation hole plugger failed to seat properly after ET separation (STS-34-20). The hole plugger stopped 2 inches short of full extension where is was jammed by the detonator booster and detonator. The electrical connector backshell was found on the runway during the postflight runway inspection. The same anomaly occurred on STS-29.

The right-hand stop bolt on the centering ring of the forward ET separation assembly was found bent during the postflight inspection (STS-34-21). This condition did not impact the ET separation.

THERMAL CONTROL SUBSYSTEM

The thermal control subsystem (TCS) operated nominally, and all Orbiter structural and component temperatures were maintained within acceptable limits for the on-orbit, entry, and postlanding phases of the mission.

AEROTHERMODYNAMICS AND THERMAL PROTECTION SUBSYSTEM

The thermal protection subsystem (TPS) performance was nominal, based on structural temperature responses, and tile surface temperature measurements. The overall boundary layer transition from laminar flow to turbulent flow was nominal, occurring at 1110 seconds after entry interface.

Debris impact damage was minimal with 51 lower-surface hits, 17 of which had at least one major dimension of 1 inch or greater. The majority of the lower-surface damage was concentrated aft of the main landing gear doors (MLGD's). The base heat shield peppering was minimal. Two, possibly four removals and replacements were identified that resulted from debris impact, including an OMS pod hit in the lower stinger area. Also, a no. 10 washer was found embedded in one of the lower surface tiles. The metal washer showed evidence of entry heating. The source of this debris has not been located.

Overall, all reinforced carbon-carbon (RCC) parts, including the chin panel, looked good. A detailed chin panel internal inspection was performed by removing four carrier-panel tiles located in the outboard corners of the chin panel. The inspection identified minor rework in the filler bar and gap fillers, and also indicated that the panel will not have to be removed during this turnaround flow. The nose landing gear door thermal barrier was intact, except for an 18-inch section of loose Nicalon sleeving. The ET door thermal barriers looked good, except for evidence of a minor flow path on the aft latch patch of the right-hand thermal barrier, possible due to interference with the baggie material. The right-hand MLGD thermal barrier was intact. The left-hand MLGD thermal barrier had three minor tears. The engine-mounted heat shield thermal curtains looked the best that has ever been observed following a flight, with minor tears in engine 1 and 2 blankets. The body-flap cove external inspection indicated no damage.

Orbiter window 3 was heavily hazed, and minor deposits were found on the other windows. The upper midfuselage, payload bay doors, OMS pods, and vertical stabilizer all looked nominal with minor to no damage.

The elevon-elevon gap flight demonstration test, which used two new gap-filler materials to demonstrate potential design changes, provided useful information. Results from the test indicated that the Ceramic AMES gap fillers material performed much better than the ceramic-coated Nextel 312 and 440 materials. A total of five Nextel gap fillers breached on the left-hand side gap. Four removal and replacements were identified in this area because of damaged tiles.

A piece of ordnance-device wire shielding and a washer fell from the EO-3 fitting when the ET/Orbiter liquid oxygen umbilical door was opened. The ball fitting ordnance plunger failed to seat as reported in the Mechanical Subsystems section of this report.

DEVELOPMENT TEST OBJECTIVES AND DETAILED SUPPLEMENTARY OBJECTIVES

Thirteen development test objectives (DTO's) and nine detailed supplementary objectives (DSO's) were assigned to the STS-34 mission. Nine of the DTO's and all of the DSO's were accomplished. Preliminary results of the DTO's and DSO's are covered in the following paragraphs.

DEVELOPMENT TEST OBJECTIVES

DTO 301D - Ascent Structural Capability - The purpose of this DTO was to evaluate the Orbiter's structural capability at or near design conditions during ascent. The data obtained were limited as this Orbiter (OV-104) has only midbody strain instrumentation installed. This is a data-only DTO.

DTO 307D - Entry Structural Capability - The purpose of this DTO was to evaluate the Orbiter's structural capability at or near design conditions during entry. The data obtained were limited as this Orbiter (OV-104) has only midbody strain instrumentation installed. This is a data-only DTO.

DTO 309D - Ascent Flutter Boundary Evaluation - The objective of this DTO was to better define the ascent flutter boundaries that would lead to an expansion of the ascent design criteria to a maximum dynamic pressure of 819 psf. The maximum dynamic pressure attained on this flight was not sufficient to accomplish this DTO. This is a data-only DTO.

DTO 311D - POGO Stability Performance - The objective of this DTO was to obtain flight data that will lead to the definition of POGO (longitudinal stability) margins during ascent. The data were collected and are being analyzed by the sponsor. The intent of this DTO is primarily to obtain data to assess whether POGO occurred, rather than to develop detailed analyses of the dynamics involved. This is a data-only DTO.

DTO 312 - ET TPS Performance - The objective of this DTO was to photograph the ET following Orbiter/ET separation. The photographs will be used to assess the performance of the ET's thermal protection system.

DTO 318 - Direct Insertion ET Tracking for the ETR - The purpose of this DTO was to obtain tracking data for the entry, rupture, and breakup of the lightweight ET's. These data will provide greater confidence in ET impact footprint size predictions and increased flexibility in future ET impact targeting. For the STS-34 mission, the ET impact areas was in daylight, consequently no useful data were obtained.

DTO 517 - Hot Nosewheel Steering Runway Evaluation - This DTO was intended to verify that modified nosewheel steering is safe, reliable, and controllable during high-speed use. By gathering data under a variety of conditions (different runways, crew members, wind conditions, etc.), an assessment of the overall capability of the modified nosewheel steering can be made. The crew performed this DTO upon landing the Orbiter and reported good results. There were no problems with the nosewheel steering, and the system performed very well.

DTO 630 - Camcorder Demonstration - This DTO was performed with excellent results. The DTO objective was to assess the performance and operational usefulness of the new hand-held video camcorder. During the flight, the crew recorded and downlinked a variety of scenes, including middeck operations, earth views, and fiber scope views. The fiber scope views of the TAGS paper tray proved the operational usefulness of the camcorder by allowing flight controllers to assess the operation of the paper tray. The sponsor is very pleased with the results of this DTO.

DTO 703 - TDRS to TDRS Handover Demonstration - This DTO was designed to demonstrate S-band and Ku-band Tracking and Data Relay Satellite (TDRS)-to-TDRS handover capability. The DTO was performed several times during the course of the flight. Because of antenna blockage, the Ku-band portion of the DTO was unsuccessful; the S-band portion was successful and the sponsor reports that the initial results look good.

DTO 638 - Potable Water Gas Bubble Sample Collection - The objective of this DTO was to collect samples of the Orbiter's potable water for postflight analysis of gas-bubble content. The DTO specified three samples (flight day 1, midflight, and on entry day); however, only two were collected (one on flight day 1 and the other on flight day 4). The preliminary analysis of the water samples showed that the gas bubble content was very small (< 0.5cc). The sponsor reports that these results seem to indicate that the gas bubbles frequently reported by the crews will not be a problem with the new beverage pouch.

DTO 786 - Text and Graphics System - The TAGS was used several times during STS-34 thus satisfying the objective of this DTO, which was to evaluate the performance of the TAGS under microgravity conditions. The specific objective of DTO 786 was to process 400-600 sheets of paper, and over 500 sheets were processed. The crew reported that the page had outstanding image quality, but the sponsor reported that there are significant operational difficulties with the TAGS that must be resolved. Performing this DTO on STS-34 officially satisfies the overall objectives of the DTO. The sponsor considers the DTO complete and does not desire another performance on a subsequent mission.

DTO 805 - Crosswind Landing Performance - This DTO was deleted from the flight plan prior to entry day because of the APU overspeed problem.

DTO 816 - Gravity Gradient Attitude Control - The objective of this DTO was to find the optimum gravity-gradient attitudes that would minimize attitude oscillations, fuel usage, induced contamination and acceleration. This DTO was successfully performed, and the sponsor reports good results. The DTO consisted of two parts - a long-term (12-hour) test and a short-term (1 1/2- to 4 1/5-hour) test. During the performance of the DTO, the initial attitude was deliberately biased 1.5 degrees in pitch and yaw away from the gravity-gradient attitude. The Orbiter settled into a stable gravity-gradient attitude despite the bias. The sponsor reports that the guidance, navigation and control community is very pleased with the Orbiter performance, and future iterations of the DTO will introduce larger initial biases to fully assess the gravity-gradient attitude envelope.

DETAILED SUPPLEMENTARY OBJECTIVES

DSO 457 - Salivary Pharmocokinetics of Scopolamine and Dextroamphetamine - All planned data were collected.

DSO 466 - Preflight and Postflight Cardiovascular Assessment - All planned data were collected.

DSO 470 - Doppler Measurement of Middle Cerebral Arterial Velocity - All planned data were collected.

DSO 474 - Retinal Photography - All planned data were collected.

DSO 475 - Muscle Biopsy - All planned data were collected.

DSO 477 - Muscle Performance - All planned data were collected.

The sponsors report that all medical DSO's were successfully accomplished and the data look good. There were no hardware problems. A separate report of the preliminary data analysis and findings will be released by the sponsors.

EXPERIMENTS

The STS-34 mission was very successful in the area of experiments. The Shuttle Solar Backscatter Ultraviolet Spectrometer (SSBUV) completed all earth-view mode objectives except for one orbit, which was not completed because the mission was shortened two orbits. All IMAX Camera film was exposed, and all Growth Hormone Concentration and Distribution in Plants (GHCD) operations were completed on flight day 4. Between 78 and 93 percent of the Polymer Morphology (PM) experiment objectives were completed. The Sensor Technology Experiment (stem) was activated on flight day 1 and deactivated on flight day 5. Lightning observations and documentation for the Mesoscale Lightning Experiment (MLE) were excellent with numerous "fantastic" lightning shows observed. The ice crystal student experiment failed to provide any ice crystal growth on the first attempt: however, after implementation of "troubleshooting" procedures, successful ice crystal growth was observed.

TABLE I.- STS-34 SEQUENCE OF EVENTS

Event	Description	Actual time, G.m.t.
APU activation	APU-1 GG chamber pressure	291:16:48:49.65
	APU-2 GG chamber pressure	291:16:48:50.83
	APU-3 GG chamber pressure	291:16:48:51.86
SRB HPU activation	LH HPU system A turbine speed	291:16:53:12.20
	RH HPU system A turbine speed	291:16:53:12.52
Main propulsion System start	Engine 3 start command to EIU	291:16:53:33.476
	Engine 2 start command to EIU	291:16:53:33.602
	Engine 1 start command to EIU	291:16:53:33.751
SRB ignition command (lift-off)	SRB ignition command to SRB	291:16:53:40.020
Throttle up to 104 percent thrust	Engine 3 command accepted	291:16:53:43.976
	Engine 2 command accepted	291:16:53:44:002
	Engine 1 command accepted	291:16:53:44.031
Throttle down to 65 percent thrust	Engine 3 command accepted	291:16:54:07.837
	Engine 2 command accepted	291:16:54:07.843
	Engine 1 command accepted	291:16:54:07.872
Maximum dynamic pressure (q)	Derived ascent dynamic pressure	291:16:54:29.9
Throttle up to 104 percent thrust	Engine 3 command accepted	291:16:54:38.718
	Engine 2 command accepted	291:16:54:38.724
	Engine 1 command accepted	291:16:54:38.752
Both SRM's chamber pressure at 50 psi	LH SRM chamber pressure mid-range select	291:16:55:39.46
	RH SRM chamber pressure mid-range select	291:16:55:38.94
End SRM action	LH SRM chamber pressure mid-range select	291:16:55:42.058
	RH SRM chamber pressure mid-range select	291:16:55.41.458
SRB separation command	SRB separation command flag	291:16:55:42 - 45 (Data dropout)
SRB physical separation	SRB physical separation	
	LH APU A turbine speed LOS*	291:16:55:44.90
	LH APU B turbine speed LOS*	291:16:55:44.94
	RH APU A turbine speed LOS*	291:16:55:44.94
	RH APU B turbine speed LOS*	291:16:55:44.90
Throttle down for 3g acceleration	Engine 3 command accepted	291:17:01:12.972
	Engine 2 command accepted	291:17:01:12.976
	Engine 1 command accepted	291:17:01:13.003
3g acceleration	Total load factor	291:17:01:12.8
MECO	MECO command flag	291:17:02:11.9
	MECO confirm flag	291:17:02:11.9
ET separation	ET separation command flag	291:17:02:30.1
OMS-1 ignition	Left engine bi-prop valve position	Not required for direct ascent
APU deactivation	APU-1 GG chamber pressure	291:17:09:01.56
	APU-2 GG chamber pressure	291:17:09:02.11
	APU-3 GG chamber pressure	291:17:09:02.85

* = loss of signal

TABLE I.- CONCLUDED

Event	Description	Actual time, G.m.t.
OMS-2 ignition	Left engine bi-prop valve position	291:17:33:35.7
	Right engine bi-prop valve position	291:17:33:35.7
OMS-2 cutoff	Left engine bi-prop valve position	291:17:35:56.5
	Right engine bi-prop valve position	291:17:35:56.5
Galileo deployment	Voice call	291:23:15:03
OMS-3 ignition	Left engine bi-prop valve position	291:23:30:02.2
	Right engine bi-prop valve position	291:23:30:02.2
OMS-3 cutoff	Left engine bi-prop valve position	291:23:30:19.0
	Right engine bi-prop valve position	291:23:30:19.0
Galileo IUS burn	Voice call	292:00:15:15
Flight control system checkout		
APU start	APU-3 GG chamber pressure	295:12:11:03.58
APU stop	APU-3 GG chamber pressure	295:12:16:43.55
APU activation for entry	APU-2 GG chamber pressure	296:15:26:50.41
	APU-3 GG chamber pressure	296:15:49:21.23
	APU-1 GG chamber pressure	296:16:21:12.68
Deorbit maneuver ignition	Left engine bi-prop valve position	296:15:31:45.0
	Right engine bi-prop valve position	296:15:31:45.0
Deorbit maneuver cutoff	Left engine bi-prop valve position	296:15:34:31.4
	Right engine bi-prop valve position	296:15:34:31.4
Entry interface (400k)	Current orbital altitude above reference ellipsoid	296:16:02:15
Blackout end	Data locked at high sample rate	No blackout because of TDRS
Terminal area energy management	Major mode change	296:16:26:39
Main landing gear contact	LH MLG tire pressure 1	296:16:33:04
	RH MLG tire pressure 1	296:16:33:01
Nose landing gear contact	NLG tire pressure 1	296:16:33:11
Wheels stop	Velocity with respect to runway	296:16:34:01
APU deactivation	APU-1 GG chamber pressure	296:16:34:25.08
	APU-2 GG chamber pressure	296:16:49:39.84
	APU-3 GG chamber pressure	296:16:49:41.19

TABLE II.- STS-34 PROBLEM TRACKING SUMMARY

Number	Title	Reference	Comments
STS-34-01	DDU 1 Changeout	Prelaunch IPR 34RV-0226 PR DIG-144 IM 34RF-01	AMI biased. KSC troubleshooting indicated DDU malfunctioned. Changed out DDU 1. Retest OK. Close.
STS-34-02	Engine Interface Unit 3 Bite 13 (Momentary)	291:09:00 G.m.t. Prelaunch IPR 34RV-0241 PR DIG-A0009 MCR-14699 IM 34RF-02	EIU 3 Bite 13 set and 60 Kbit data stream lost for 5.3 seconds. Recurrence would result in loss of 60 Kbit data. LCC deviation for LO_2 dome temperature. However, a ground TV camera can be used for backup to LO2 dome temperataure. EIU's will be removed and retrofitted this flow.
STS-34-03	Instrumentation a) APU 3 Injector Temperature (V46T0374)	a) 291:15:47 G.m.t. Prelaunch IM 34RF-03 IPR 34RV-0246 IPR 36RV-0022	a) APU 3 injector temperature biased low (315 s/b 355). KSC saw fluctuation.
	b) APU 3 EGT 1 Failed (V46T0242)	B) 291:16:49 G.m.t. IM 34RF-04	b) APU 3 EGT 1 failed low prelaunch. Remove and replace, if required.
	c) APU 3 EGT 2 Failed	c) IM 34RF-18	c) APU 3 EGT 2 erratic during ascent and failed during FCS checkout. Remove and replace, if required.
	d) APU 2 EGT 1 Failed (V46T0242)	d) IM 34RF-19	d) APU 2 EGT 1 failed during entry. Remove and replace, if required.
	e) WSB 3 Reg Out Press Failed (V58P0304A)	e) IM 34RF-20	e) WSB 3 regulator outlet pressure (V58P0304A) failed. IPR 36RV0002 Ground tests could not reproduce failure.
STS-34-04	APU 1 Fault to High Speed	291:16:55 G.m.t IPR 36RV-0025 IM 34RF-05	APU 1 experienced an inadvertent speed shift to the high-speed band during ascent. Operated satisfactorily for remainder of ascent. Turned on APU-1 at Mach-10 and off at postlanding wheel stop. Sniff test and visual inspection showed no problems
STS-34-05	FA 1 Input/Output Error	291:17:29 G.m.t. IPR 36RV-0024 IM 34RF-06	MDM FA 1 failed at the MDM as detected by both PASS and BFS. Recovered MDM by port moding string 1 to secondary ports. Troubleshooting shows port 1 inoperative. MDM removed and replaced. Close.
STS-34-06	APU 2 GG/FP Heater A Inoperative	291:22:00 G.m.t. PR-UA-4A0007 IM 34RF07	APU 2 fuel pump/GGVM system A heaters did not respond when selected. System B heaters selected and operated properly, until 294:03:00 G.m.t. (see STS-34-10). Ferry on A heaters which worked postlanding. Remove thermostats for vacuum test which showed acceptable operation. Unit shipped to Sunstrand for analysis.

TABLE II.- STS-34 PROBLEM TRACKING SUMMARY

Number	Title	Reference	Comments
STS-34-07	FES High Load Inboard Duct Temperature Low	291:17:06 G.m.t. IM 34RF-08	At 12 minutes 34 seconds after lift-off, the high load inboard duct temperature (V63T1820A) was observed decreasing. Both heaters were enabled on the high load duct. Approximately 3 minutes later, the crew shut down FES primary A and switched to secondary. The temperature continued to decrease. The system stabilized under RAD flow. Heaters left on for bakeout. On Flight Day 2, the topping FES functioned properly on primary A and primary B controllers. Suspect excess water in high load during ascent due to RTG extra head load. KSC plans normal turnaround.
STS-34-08	APU 3 Seal Leak Into Drain Bottle	291:12:00 G.m.t. IPR 36RV-0027 IM 34RF-09	APU 3 cavity seal drain line pressure increasing (V46P0390A) and fuel pump inlet pressure decreasing (V46P0310A). Suspect leak in static seal. STS-30 measured 30cc from drain.
STS-34-09	Right OMS Engine cover heater System B Failed Off (V43T5720A)	293:14:53:40 G.m.t. IM 34RF-13	During heater configuration to B heaters, the OMS right pod (RP03) B heaters failed to activate. KSC to inspect wiring and connectors Pod will be pulled to remove and replace two Helium regulators.
STS-34-10	APU 2 Fuel Pump Heater B Cycling High	294:03:00 G.m.t. IPR 36RV-0026 IM 34RF-11	APU fuel pump heater B has been cycling erratically toward higher temperatures. KSC remove thermostat and send to Sunstrand for failure analysis.
STS-34-11	70MM Hasselblad Camera Shutter Failed Closed	294:13:08 G.m.t.	The Shutter on the 100mm lens closed and will not open. In this configuration, the lens cannot be removed from the camera body.
STS-34-12	Cryo O2 Manifold 2 Isolation Valve did not close	293:02:29 G.m.t. IM 34RF-12	The crew attempted to close the cryo O2 manifold tank 2 valve from panel R-1 per the sleep configuration. Crew reported they held switch for 5 seconds. No talkback. No switch discrete (V45X1146E). Switch operated normally later in the flight.
STS-34-13	TAGS Overtemp Indication	294:01:08 G.m.t. MCR 15463	Several false overtemperature indications cleared by power cycle. Later overtemperature indications stayed on. TAGS continued DTO. Removed TAGS and sent to JSC for evaluation.
STS-34-14	S-Band URF Antenna (Elect 2) Failed to Switch	295:10:05 G.m.t. IPR 36R-0028	SM GPC issued an antenna message. Message caused by S-Band control assembly failure to select proper beam direction. Troubleshooting confirmed the URF failed to select properly. Upper right forward antenna switch coil open.
STS-34-15	Pilot HSI 'Pri Mile' Erroneous During FCS Checkout	295:12:40 G.m.t. IPR 36RV-0029 IM 34RF-14 PR DIG-0147	Crew reported that during FCS dedicated display Checkout the right HSI primary miles indicated 3300 vs. 3000 required. Low test 300 vs. 200. Retest same results high. Low OK. During ascent, condensation noted inside meter. KSC will remove and replace HS1.
STS-34-16	a)"Darkened Arc" across CCTV Camera C b)Camera B had spots on screen	294:07:00 G.m.t.	a) An area of degraded image was noticed on CCTV camera C. Area is darkened and extends through center of image. KSC remove and send to JSC. b) Camera B had spots on screen. KSC remove and ship to JSC.

TABLE II.- STS-34 PROBLEM TRACKING SUMMARY

Number	Title	Reference	Comments
STS-34-17	S-Band ULF Antenna (Elect 1) Failed to Switch	295:23:58 IM 34RF-15	During transition from ULA to ULF, antenna electronics 1 failed to select the forward antenna. Telemetry indicated that neither antenna was selected. Corrected by cycling to Elect 2 then back to Elect 1. Remove and replace switch beam assembly.
STS-34-18	WSB 2 Vent Temperature No Response Controller 'A' (V58T0165A)	296:13:45 G.m.t. IPR 36RV-0031 IM 34RF-16	WSB 2 steam vent temperature heater A did not respond. Switched to B controller with normal response. Could be heater or controller. KSC troubleshooting could not reproduce failure.
STS-34-19	Right Vent Door 3 Motor 1 Operating on 2 Phases	291:16:53 G.m.t. Prelaunch IPR 36RV-0032 IM 34RF-17	During prelaunch when vent doors pre-positioned, right vent door 3 motor 1 operated on 2 phases. AC1 phase B was lost. Previous problem with same door. Occurred when door functioned. Phase B when open and Phase C when closed. Previous problem during STS-30 flow was dispositioned on IPR 30RV-0066 and UA0034. Testing has reproduced the problem.
STS-34-20	ET/ORB Lox Aft Separation Hole Plugger Failed	ET SEP PR PYR-4-06-0082	ET/ORB Lox aft separation hole plugger failed to seat properly. Stopped 2 inches short of full extension. Jammed by detonator booster and detonator. Connector backshell found on runway. All ET debris accounted for. Pictures taken. Same anomaly STS-29. Design fix in work.
STS-34-21	RH Stop Bolt Bent on Centering Ring of FWD Sep. Assembly	PR PYR-4-06-0085	RH stop bolt bent on centering ring of forward separation assembly. Parts to RI-Downey. Photos to JSC. OV-102 forward separation bolt inspected prior to rollout.

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730.1/J. P. Young
400/D. W. Harris
400/P. T. Burr
410/J. Barrowman (6)
302/W. F. Bangs
313/R. Marriott

KSC
NWSI-D/Respository (25)

MSFC
CN22D/Respository (30)
EP51/J. Redus (5)
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R16G/J. Woodard
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JSC
AA/A. Cohen
AC/D. A. Nebrig
AC5/J. W. Young
AP3/J. E. Riley (4)
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CB/D. C. Brandenstein (5)
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DM/C. F. Deiterich
EA/H. O. Pohl
EC/W. W. Guy
EC/F. H. Samonski
EC2/D. F. Hughes
EC3/M. Rodriguez
EC4/L. O. Casey
EC6/E. Winkler
EC6/J. W. McBarron (5)
EC6/D. M. Hoy
ED3/R. Barton
EE/J. H. Johnson
EE2/H. A. Vang
EE7/O. L. Schmidt
EE7/J. C. Dallas
EF/I. Burtzlaff
EF3/J. A. Lawrence
EH/K. J. Cox
EH/P. C. Kramer
EH2/L. B. McWhorter
EH2/J. E. Yeo
EH4/W. N. Trahan
EP/C. A. Vaughn
EP2/H. J. Brasseaux
EP2/L. Jenkins
EP5/C. R. Gibson
EP5/N. Faget
ES/D. C. Wade
ES/W. G. McMullen (2)
ES3/J. A. Smith
ES3/C. R. Ortiz
ES3/L. D. Palmer
ES3/Y. C. Chang
ES6/C. W. Norris (2)
FA/R. L. Berry
FA/J. R. Garman
FD3/S. Morris
FM/C. A. Graves, Jr. (8)
FM/E. R. Schiesser
FR/E. S. Chevers
FR/SSD Library
FS/J. W. Seyl (2)
GA/L. S. Nicholson
GA/J. H. Greene
GM/D. C. Schultz
JL4/R. L. Squires
JM2/Library (3)
MA/B. Shaw, Jr.
MJ/R. Thorsen (3)
NA/C. S. Harlan
NB/D. L. Duston
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